



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/US98/00997 (22) International Filing Date: 20 January 1998 (20.01.98) (30) Priority Data: 08/787,967 23 January 1997 (23.01.97) US (71) Applicant: SWAGelok MARKETING CO. [US/US]; 31400 Aurora Road, Solon, OH 44139 (US). (72) Inventor: JOHNSTON, Lonnie, E.; 7791 S. Riverside Drive, Aurora, OH 44202 (US). (74) Agents: LEWIS, Leonard, L. et al.; Calfee, Halter &amp; Griswold, LLP, 1400 McDonald Investment Center, 800 Superior Avenue, Cleveland, OH 44114-2688 (US).</p>		<p>(81) Designated States: AU, CA, CN, DE, GB, IL, JP, KR, MX, SG, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>
<p>(54) Title: PHASE-CONTROLLED SEQUENTIAL-GRIPPING TUBE FITTING</p> <div data-bbox="402 1163 1185 1575"> </div> <p>(57) Abstract</p> <p>A phase-controlled, sequential-gripping tube fitting includes a main fitting body (10) having a tube end receiving opening (24) with a tapered camming mouth (28) forming the entry to the opening. A front ferrule (36) with a tapered forward nose surface (44) is engaged with the camming mouth (28) and includes a rear surface (46) with a conically tapered recess extending forwardly toward the nose surface (44). Extending into the conically tapered recess (46) of the front ferrule (36) is a rear ferrule (38) having a rear force receiving surface (60). A coupling nut (14) is threadedly connected to the main body (10) and has a force applying face (62) engaged with the rear force receiving surface (60) of the rear ferrule (38). An arrangement is provided to control outward buckling of the rear ferrule (38). The arrangement includes a central body (54) located between the nose portion (52) and the rear force receiving surface (60) of the rear ferrule (38). A cylindrical flange (66) extends rearwardly from the front ferrule (36) at a location radially outwardly of the rear recess (46). The flange (66) has a cylindrical interior surface (68) that closely surrounds the central body (54). The central body (54) is of a length such that engagement between the coupling nut (14) and the axial end face (66a) of the cylindrical flange of the front ferrule (36) is not possible at any point during make-up.</p>		

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## PHASE CONTROLLED SEQUENTIAL GRIPPING TUBE FITTING

Technical Field

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The subject invention is directed toward the art of tube fittings and more particularly, to an improved phase-controlled, sequential-gripping tube fitting.

10

Background of the Invention

The general form of tube fitting with which this invention is concerned is described and claimed in the following series of U.S. patents which are incorporated herein by reference: 2,484,815 issued October 18, 1949, 3,075,793  
15 issued June 29, 1963, 3,103,373 issued September 10, 1963, 4,826,218 issued May 2, 1989 and 4,915,427 issued April 10, 1990.

U.S. Patent No. 4,915,427 discloses and claims a phase-controlled, sequential-gripping tube fitting  
20 particularly suitable for use on heavy-walled tubes. The arrangement of the patent obtains proper pull-up and action in a two ferrule fitting for heavy-walled tubes by using ferrules having a relatively heavy and substantial construction including heavily flanged rear end portions. In addition, the  
25 coupling nut portion surrounding the ferrules is arranged to closely enclose the flanged rear end portions of the ferrules.

While the described arrangement works very satisfactorily, it would be more desirable to obtain equivalent functioning with lighter weight ferrules without  
30 relying on the heavy rear flange design.

The subject invention provides an arrangement which overcomes the above-discussed disadvantage of the prior design and allows relatively light weight ferrules to perform satisfactorily with heavy walled tubing by controlling and

containing the ferrule swaging action in a manner which prevents undesirable ferrule deformation. The design prevents excessive "bear claw" deformation of the rear ferrule and assures that the rear ferrule transmits the necessary driving  
5 forces to the front ferrule prior to full engagement of the rear ferrule with the tube.

### Summary of the Invention

In accordance with a one aspect of the invention, a  
10 phase controlled, sequential gripping tube fitting including a main body having a cylindrical tube end receiving opening with a tapered camming mouth forming the entry to the opening has a front ferrule with a tapered forward nose surface in engagement in the camming mouth and a rear surface with a  
15 conically tapered recess that extends forwardly toward the nose surface. A rear ferrule having a conically tapered nose is positioned so that the tapered nose extends into the conically tapered recess of the front ferrule. The rear ferrule further includes a rear force engaging surface.  
20 Threadedly connected to the main body is a coupling nut engaged with the rear force receiving surface of the rear ferrule to drive the rear ferrule axially forward into the conically tapered rear surface of the front ferrule and produce radial inward movement of the nose portion of the rear  
25 ferrule as well as radial inward movement of the nose portion of the front ferrule. The assembly includes an improved arrangement to control outward buckling of the rear ferrule. The arrangement includes a cylindrical central body on the rear ferrule with the central body located between the nose  
30 portion and the rear force receiving surface. Associated with the central body is a cylindrical flange portion formed on the front ferrule and extending axially rearwardly therefrom at a location radially outward of the rear recess of said front ferrule. The cylindrical flange has a cylindrical interior  
35 surface that closely surrounds the cylindrical central body of the rear ferrule to limit radial outward movement of the rear ferrule or portions thereof.

In another aspect of the invention a phase-controlled, sequential-gripping tube fitting includes a main body having a tube end receiving opening with a tapered camming mouth; a front ferrule having a tapered forward nose for engagement in the body camming mouth; a rear ferrule having a tapered nose extending into a tapered rear recess of the front ferrule and a rear force receiving surface, a coupling element operable with the main body to pull-up the fitting and having a force-applying face engaged with the rear force-receiving surface of the rear ferrule to drive the rear ferrule axially forward into the rear recess of the front ferrule and produce radial inward movement of the rear ferrule nose portion, the improvement comprising: an arrangement to reduce radial outward movement of the rear ferrule and including a central body on the rear ferrule, the central body located between the rear ferrule nose portion and the rear force receiving surface, and a rear portion of the front ferrule extending rearwardly from the front ferrule at a location radially outward of the rear recess of the front ferrule, the rear portion of the front ferrule having a surface that reduces radial outward movement of the rear ferrule as the fitting is pulled-up.

Still other advantages and benefits of the invention will become apparent to those skilled in the art upon a reading and understanding of the following detailed description.

#### Brief Description of the Drawings

The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment and method of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof, and wherein:

FIGURE 1 is a partial side elevational view in cross section of a coupling device which employs a female coupling nut and with no associated tube member being shown;

FIGURE 2 is a view similar to FIGURE 1 with a tube member inserted into the coupling and the coupling components made up to a finger-type relationship;

FIGURE 3 is a view like FIGURE 1 but showing the fitting in its made up condition with the ferrules in their tube gripping positions; and,

FIGURE 4 is a greatly enlarged view of the circled portion of FIGURE 1.

#### Detailed Description of the Preferred Embodiment

Referring now to the drawings wherein the showings are for the purposes of illustrating the preferred embodiment of the invention only and not for purposes of limiting same, the FIGURES 2 and 3 generally show a coupling body 10 with a tubular member 12 associated therewith and received therein. Suitable gripping and sealing engagement between the body 10 and the tube member 12 is achieved through the use of a coupling nut 14 and a ferrule arrangement 16.

In the subject arrangement, the coupling body 10 has a first end 20 and an associated second end (not shown). It should be understood that the coupling body 10 could be associated with any type of second end or associated structure and could be formed directly on a fluid flow device, such as a valve or the like. As can be appreciated, however, the coupling body 10 includes an internal flow passage 22 that joins with a cylindrical bore 24 extending axially inward of the first end 20. The bore 24 is preferably coaxial with the internal flow passage 22 and the juncture between bore 24 and flow passage 22 provides a radial end wall or shoulder 26. The diameter of counterbore 24 is, as can be seen from FIGURES 2 and 3, sized so as to closely but slidably receive the end of the tube 12. The shoulder 26 provides an inward limit stop for the tube 12 and locates the tube end relative to the ferrule arrangement 16. An outer counterbore 28 extends from counterbore 24 to the outer end of the fitting body and has a

generally conical shape expanding radially outwardly to define a tapered, conical camming mouth 28 about the bore 24.

The coupling nut 14 is preferably of hex-shaped exterior configuration and has a central bore that is threaded as illustrated at 30 and cooperates with external threads 32 formed about the exterior of the body 10 on the first end 20. The coupling nut 14 acts to drive the ferrule arrangement 16 into its sealed and gripping relationship in a manner subsequently to be described. For the present, it should be noted that the axial outer end of the coupling nut 14 includes a central bore 34 that is sized so as to closely encircle the exterior of the tube 12.

Referring in particular to FIGURES 1 and 4, the details and preferred construction for the ferrule arrangement 16 can best be understood. In particular, the assembly includes a front ferrule 36 and a rear ferrule 38. The front ferrule 36 has a central through opening 40 which is cylindrical in shape and sized so as to closely but slidably receive the tube 12. The exterior of the ferrule 36 is of tapered configuration as shown and tapers at an angle  $\alpha$  only slightly less than the taper angle of the camming mouth 28. Preferably the angle  $\alpha$  is in the range of 10 to 30 degrees. The corresponding angle of the camming mouth 28 is generally slightly greater, as shown. The tapered outer surface 42 extends substantially the length of the ferrule from the nose 44 to adjacent the rear surface of the ferrule. The rear surface of the front ferrule 36 includes a conically tapered rear force receiving surface 46 that is inclined or tapered at an angle in the range of about 40 to 50 degrees generally, as shown.

Cooperating with the front ferrule 36 is the second or rear ferrule 38 which has a central through opening 50 that generally corresponds in diameter to the central through opening 40 of the front ferrule 36. This opening 40 is also

arranged so as to closely but slidably receive the tube 12. The forward or axial inner end of the rear ferrule 38 is tapered so as to generally correspond to the taper of the force receiving recess 46 of the front ferrule 36. Axially rearward of the inner or nose end 52 of ferrule 38 is a central body section 54 of cylindrical configuration. The axial outermost or right-hand end of the ferrule 38 is of slightly greater diameter as seen at 56 to define a radially extending end flange having a cylindrical radial outer side face 57. A counterbore 58 within the coupling nut 14 is sized and arranged so as to totally enclose the flange defined by portion 56 of ferrule 38. In addition, a slightly tapered or inclined end wall 60 on ferrule 38 is arranged to correspond with the angled inner shoulder 62 of the nut 14 and act as a force receiving surface when the nut 14 is tightened to body 10 to move the ferrules to their tube gripping and sealing position shown in FIGURE 3.

Of particular importance to the invention is the relationship between the rear of the front ferrule 36 and the forward, cylindrical body portion 54 of the rear ferrule 38. In particular, it will be seen that the front ferrule 36 includes an axially rearwardly extending cylindrical flange portion 66 that defines a cylindrical bore 68 leading to the force receiving inclined surface 46. This cylindrical bore 68 is of a length to extend preferably approximately half way along the cylindrical body portion 54 and functions to radially constrain this portion of the rear ferrule 38. Additionally, it should be noted that there is within the nut member 14 a second counterbore 70 that is sized and arranged so as to closely enclose the rear end diameter of the front ferrule 36 and constrain its radial outward movement during the tightening of the nut member 14 to the tube gripping position. In this way, both the front ferrule 36 and the rear ferrule 38 are radially constrained by the nut member 14 while



the nose portion of the rear ferrule 38 is further constrained and guided by the counterbore 68 in the rear of the front ferrule 36. By so guiding and constraining the rear ferrule at both the axial inner and outer ends, it is caused to move progressively inward while it drives the front ferrule 36 into its gripping position. This controlled movement prevents torsional twisting and constrains the gripping movement to avoid "bear clawing" or the over deflection or rolling of the nose portion 52 of the rear ferrule 38. In addition, by so moving the force receiving surface of the front ferrule 36 inwardly of the rear face, there appears to be a better ability of the rear ferrule 38 to constrain and control the forces applied thereto.

FIGURE 3 shows the components after the nut member 14 has been moved from the finger tight position of FIGURE 2 to the "made-up," fully engaged tube gripping position. It is important to note that the length of central section 54 of rear ferrule 38 is related to the counterbore 58 of the coupling nut 14 and the cylindrical bore 68 so as to prevent any possibility of engagement between the end face 66a of flange portion 66 and end face 70a of second counterbore 70 (see FIGURE 4). This assures that gap "G" is maintained at all times, even after makeup of the fitting as seen in FIGURE 3. By maintaining gap "G," a spring action is retained by the ferrules. This assures a seal is maintained throughout thermal cycling and vibration. Also, it permits subsequent remake of a fitting.

The invention has been described with reference to the preferred embodiment. obviously, modifications and alterations will occur to others upon a reading and understanding of this specification. It is intended to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

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Having thus described the invention, it is claimed:

1. A phase-controlled, sequential-gripping tube fitting comprising:

5 a main body (10) having a cylindrical tube end receiving opening (24) with a tapered camming mouth (28) forming the entry to said opening (24);

a front ferrule (36) having a tapered forward nose surface (42) in engagement in the camming mouth 28 and a rear  
10 surface (46) forming a conically tapered recess extending forwardly toward the nose surface (44);

a rear ferrule (38) having a conically tapered nose (52) extending into the conically tapered recess (46) of the front ferrule (36) and a rear force receiving surface (60);

15 a coupling nut (14) threadedly connected to the main body (10) and having a force applying face (62) engaged with the rear force receiving surface (60) of the rear ferrule (38) to drive the rear ferrule (38) axially forward into the conically tapered rear surface (46) of the front ferrule (36)  
20 and produce radially inward movement of the nose portion (52) of said rear ferrule (38); and

the improvement comprising:

an arrangement to control outward buckling of the rear ferrule (38) and including a cylindrical central body  
25 (54) on the rear ferrule (38), the central body (54) located between the nose portion (52) and the rear force receiving surface (60);

a cylindrical flange (66) extending axially and rearwardly from the front ferrule (36) at a location  
30 radially outwardly of the rear recess (46), the flange (66) having a cylindrical interior surface (68) that closely surrounds the cylindrical central body (54) of the rear ferrule (38) and an axial end face (66a) that is facing toward and axially spaced from the force applying face (70a) of the  
35 coupling nut (14).

2. The improvement as defined in claim 1 wherein the axial length of the flange (66) is no more than about one-

half the axial length of the cylindrical central body (54) of the rear ferrule (38).

3. The improvement as defined in claim 1 wherein the rear ferrule (38) includes a radially outward extending flange portion (56) between the cylindrical central body (54) and the rear force receiving surface (60).

4. The improvement as defined in claim 3 wherein the coupling nut (14) includes a first cylindrical interior wall (58) that closely surrounds the flange portion (56) of the rear ferrule (38).

5. The improvement as defined in claim 4 wherein the coupling nut (14) further includes a second cylindrical interior wall (70) axially spaced from the said first cylindrical interior wall (58), said second cylindrical interior wall (70) closely surrounding and radially containing the rear (66) of the front ferrule (36).

6. The improvement as defined in claim 1 wherein the length of the central body (54) on the rear ferrule (38) is sufficiently great to eliminate the possibility of engagement between the coupling nut (14) and the said axial end face (70a) at any time during make-up of the tube fitting.

7. The improvement as defined in claim 6 wherein the rear ferrule (38) has a radially extending flange (56) that forms the rear force receiving surface (60), the said flange of the rear ferrule (38) including a cylindrical radial outer side face (57) that is in engagement with a counterbore (58) within said coupling nut (14).

8. In a phase-controlled, sequential-gripping tube fitting comprising:

a main body (10) having a tube end receiving opening (24) with a tapered camming mouth (28);

a front ferrule (36) having a tapered forward nose (44) for engagement in the body camming mouth (28);

a rear ferrule (38) having a tapered nose (52) extending into a tapered rear recess (46) of the front ferrule (36), and a rear force receiving surface (60);

5 a coupling element (14) operable with the main body (10) to pull-up the fitting, and having a force-applying face (62) engaged with the rear force-receiving surface (60) of the rear ferrule (38) to drive the rear ferrule (38) axially forward into the rear recess (46) of the front ferrule (36) and produce radial inward movement of the rear ferrule nose  
10 portion (52);

and the improvement comprising:

an arrangement to reduce radial outward movement of the rear ferrule (38) and including a central body (54) on the rear ferrule (38), the central body (54) located  
15 between the rear ferrule nose portion (52) and the rear force receiving surface (60),

and a rear portion (66) of the front ferrule(36) extending rearwardly from the front ferrule (36) at a location radially outward of the rear recess (46) of the  
20 front ferrule(36), the rear portion (66) of the front ferrule (36) having a surface that reduces radial outward movement of the rear ferrule as the fitting is pulled-up.

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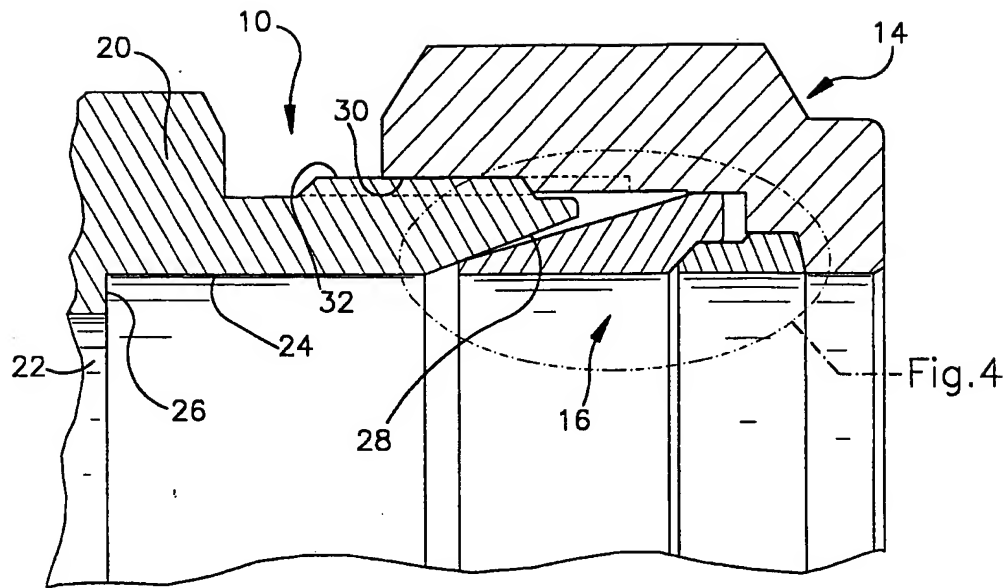


Fig.1

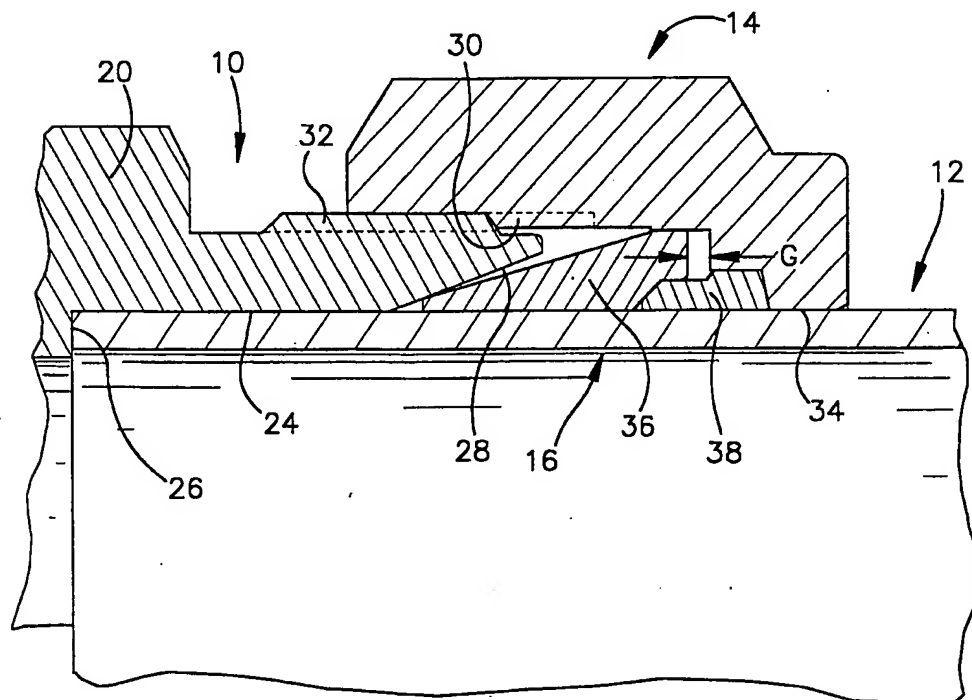
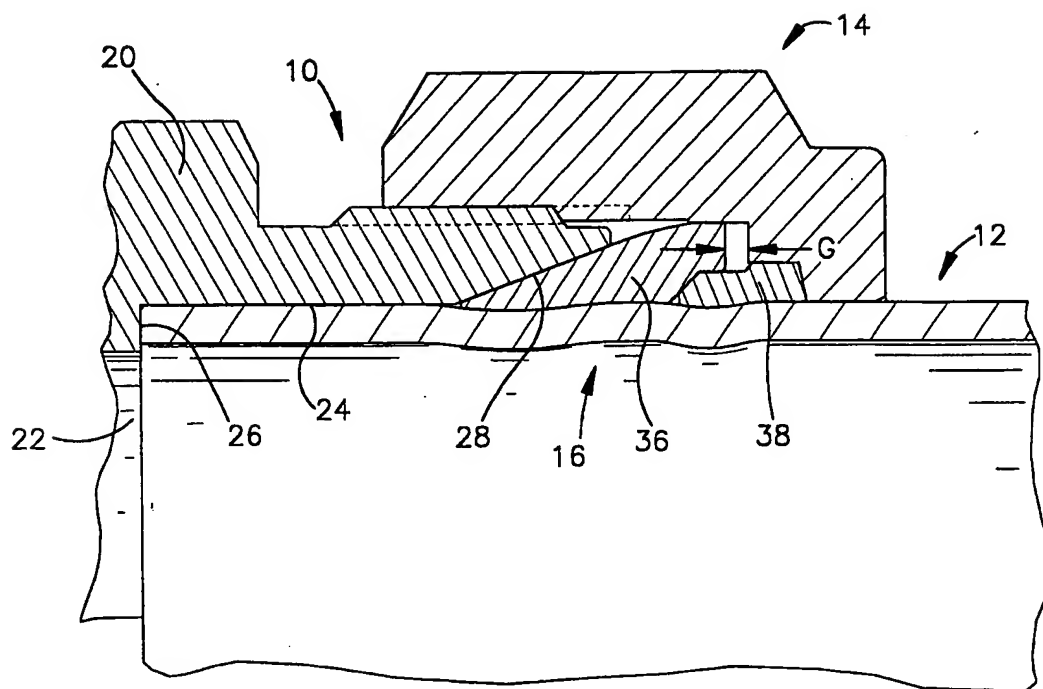
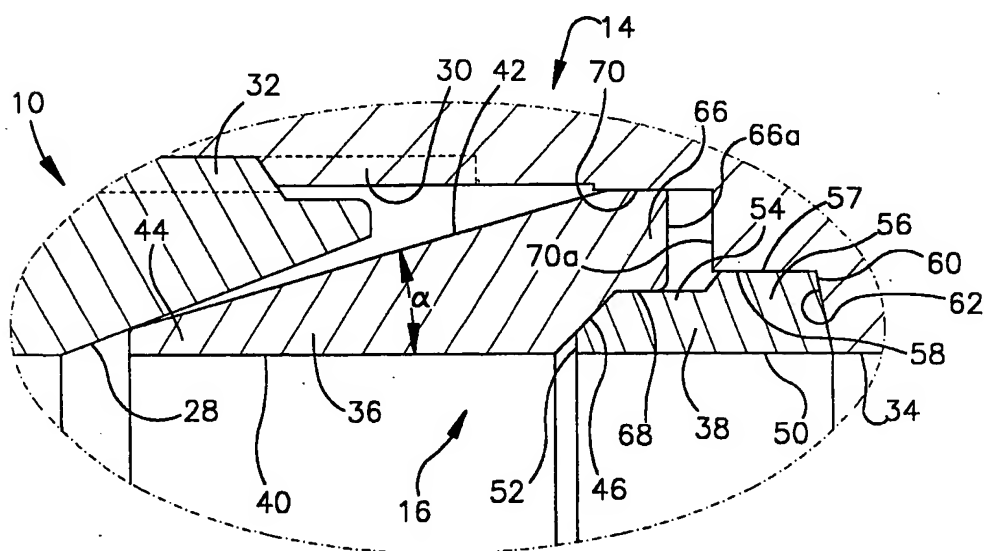


Fig.2



**Fig.3**



**Fig.4**

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 98/00997

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 F16L19/10

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BE 795 528 A (CRAWFORD CULLEN B) 18 June 1973	8
A	see figures 1-4	1-7
A	US 3 445 128 A (TEETERS WILBUR O) 20 May 1969 see column 2, line 59 - column 3, line 38; figures 1,2	1,3-5,8
A	US 4 915 427 A (ZAHURANEC EMERY J) 10 April 1990 cited in the application see column 5, line 30 - column 5, line 40; figure 3	1-8
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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# INTERNATIONAL SEARCH REPORT

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 3 103 373 A (F.A.LENNON ET AL) 10  September 1963  cited in the application  see figure 3</p> <p>-----</p>	1-8



# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 98/00997

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
BE 795528	A	18-06-1973	NONE	
US 3445128	A	20-05-1969	NONE	
US 4915427	A	10-04-1990	US 4826218 A	02-05-1989
US 3103373	A	10-09-1963	NONE	